REMARKS

Claims 16-24 are pending in the application. Claims 16-24 are rejected. Claim 7 is cancelled and claim 25 has been added. Claims 16 and 18-25 remain in the case for reconsideration. No new subject matter has been added. Reconsideration is requested.

Claim Rejections - 35 U.S.C. § 103

Claims 16 and 17 are rejected under 35 USC 103(a) as being unpatentable over Mintzer (US Patent No. 5,210,602) in view of Arce (US Patent No. 6,493,112). Claims 18-23 are rejected under 35 USC 103(a) as being unpatentable over Mintzer in view of Klassen (US Patent No. 6,483,606).

One aspect of the present invention provides a specific technique for controlling error-diffusion startup transients. None of Mintzer, Arce, or Klassen are related to controlling these error diffusion startup transcients.

Accordingly, claim 16 has been amended to specify generating a set of random seed values for initializing the error buffers and for use as initial error values for starting up an error diffusion process and initializing the error buffers associated with the array of pixels with the set of adjusted seed values prior to starting an error diffusion operation and for controlling error-diffusion startup transients. This is clearly described in FIG. 3 and in the specification at page 3 starting at line 25, page 5 starting at line 10, and further at page 7 starting at line 19.

Claim 16 has also been amended to specify adjusting each of the random seed values from the random number generator such that all of the random seed values associated with the entire array of pixels are relatively large for increasing the likelihood that dots will be printed sooner when a transition occurs between a zero image region and a nonzero image region. This is clearly described on page 5, lines 5-11.

The present invention mitigates the error diffusion startup artifacts by initializing error buffers with random values. This reduces error diffusion startup transients. Neither Mintzer nor Arce describe specific techniques that try to control error-diffusion for startup transients. Mintzer discusses a technique for reducing the amount of visually apparent texture in the output image (col. 4, lines 10-14). Arce isn't even related to error diffusion and discusses techniques for generating a noise mask to avoid problems with dot gain (col. 7, lines 24-26).

Neither Mintzer nor Arce suggest adjusting random error diffusion seed values as specified in claim 16 to reduce transients that could be generated by error diffusion when a transition occurs between a zero image region and a non-zero image region.

Mintzer discloses generating random values (column 7, lines 30- 36), but not error diffusion seed values as specified in claim 16. The error diffusion seed values as now specified in claim 16 are generated before the start of error diffusion and become the initial contents of the error buffers.

Conversely, Mintzer's random values are generated on-the-fly during the error diffusion process, to "dither the weights" used during the iterative, pixel-by-pixel calculation. Furthermore, Mintzer states that the errors are initialized to 0 at each pixel in each color plane of the image (col. 5 lines 18-22). This is contrary to what is specified in claim 16.

The limitations of claim 17 have also been added to claim 16. The Examiner states with regard to previous claim 17 that Mintzer discloses generating a set of seed values being performed at initialization of the digital image reproduction (column 7, lines 34-41 of Mintzer). The Examiner then states that without the appropriate data in the coefficient store, which is produced using the seed values (column 7, lines 34-41 of Mintzer), error diffusion cannot occur. Therefore, the generation of the set of seed values must occur at initialization of the digital image reproduction.

The rejection is respectfully traversed. As described above, nowhere does Mintzer state that the generation of the random error diffusion coefficients (by multiplying the random numbers by the constants) occurs at initialization. Regardless, values described in Mintzer are not the same error diffusion seed values specified in claim 16 that are used as initial values in the diffusion error buffers for controlling error diffusion startup artifacts.

As the Examiner notes, Mintzer also does not disclose seed values that are relatively large, likely to cause a dot to be printed, that produced a set of selected seed values. Further, there is nothing in FIG. 4, or at column 11, lines 44-48 of Arce that suggests adjusting random seed values from a random number generator such that all of the random seed values associated with the entire array of pixels are relatively large, likely to cause a dot to be printed, producing a set of selected seed values that increase the likelihood that dots will be printed sooner when a transition occurs between a zero image region and a nonzero image region.

Arce describes a method for producing a "green-noise" halftone mask (col. 9, line 50 to col. 11, line 25) to be used in conventional threshold-based halftoning (col. 9, lines 35-50). Arce has nothing to do with performing a half toning operation via an error diffusion technique. The random value in Arce appears to provide a "dot profile" (i.e. a binary "bit pattern" representing a "lightest gray level") that is then used to build up the green-noise mask. This green noise mask building process occurs offline and not at the time when an image is actually halftoned.

For example, Arce in step 1 in FIG. 4 and at column 11, lines 44-48 discloses generating a binary MxN white noise pattern so that $x_1[m, n, g]$ has as close to g-N-M pixels as possible set to one while the remaining pixels are all set to zero. This doesn't suggest generating random seed values to relatively large values that are likely to cause a dot to be printed, producing a set of selected seed values that increase the likelihood that dots will be

printed sooner when a transition occurs between a zero image region and a nonzero image region.

Conversely, the process described in FIG. 4, step 1 of Arce is used for generating a green-noise mask. Col. 11, lines 37. Input grey scale pixel values are compared with the green-noise mask array to generate a binary image array (col. 4, lines 5-10). This is conventional threshold-array-based halftoning, not error diffusion. A pixel value in the mask is directly compared against a pixel value in the image and if the image pixel value exceeds the mask pixel value then a 1 is output.

Generating a binary MxN white noise pattern so that $x_1[m, n, g]$ has as close to g-N-M pixels as possible set to one while the remaining pixels are all set to zero does not suggest that corresponding output pixel values will more likely be one. In fact, depending on the associated thresholds used for comparing input pixels with the green-noise mask, increasing the values in the green-noise mask value could cause fewer pixels to be output.

Regardless, there is simply no suggestion that the operation in Step 1 of Arce will increase the likelihood that dots will be printed sooner when a transition occurs between a zero image region and a nonzero image region. Since Arce's mask isn't used in error diffusion, there are no errors available to be biased, offset, etc., to try to affect the behavior near image transitions. Threshold-array halftoning is agnostic of image transitions and is not associated with error diffusion.

Accordingly, claims 16 and 17 are allowable under 35 USC 103(a) over Mintzer in view of Arce.

Regarding claims 18-23, the Examiner says that Mintzer discloses generating a first, second and third set of random seed values and then populates three error buffers with the sets of seed values. The Examiner further states that Klassen discloses negatively correlating black and the other colors before the application of error diffusion. The Examiner further

states that this undercolor removal provides a negative correlation between black and the other colors. Based on this negative correlation, scalar error diffusion is then performed on black and vector error diffusion is performed on the remaining colors.

Undercolor removal is often done to limit total ink coverage or to reduce artifacts from spatial misregistration of Cyan/Magenta/Yellow (CMY). Other treatments (such as no undercolor removal combined with full black generation) are also commonly used, particularly with some types of image content, and can result in a broader gamut (in darker colors especially) and can exhibit a positive correlation of K to the other colorants.

Klassen requires aggressive (i.e., complete or nearly complete) undercolor removal (col. 11, lines 41-45) to assure that black dots won't be produced in the vector error diffusion of CMY.

Conversely, claim 18 as specified provides a scheme for initializing error buffers prior to running separate error diffusion processes on different color planes, such as C, M, Y, K. By scrambling the startup transients of the error diffusion process as specified in claim 18, generated halftone dots for the individual color planes are very unlikely to start out in lock step with each other.

For example, all error buffers may be initialized identically (at corresponding pixels) say to 0 as Mintzer suggests. If identical, independent, scalar error diffusion calculations are then carried out on the CMYK separations of an image in a top-to-bottom, left-to-right, raster scan order, and if each pixel of the image in the upper-left region happens to have, say, C = M (no matter how the values change from pixel to pixel), then the error diffusion process will otherwise produce dot-on-dot (CM) outputs until some other image feature is encountered (where C and M become unequal) to break up the pattern.

Thus, the combination of Mintzer and Klassen would not eliminate the same artifacts as would the system specified in claim 18 that provides random error diffusion seed values

for each color plane. Accordingly, claims 18-23 are allowable under 35 USC 103(a) over Mintzer in view of Klassen.

Claim 24 is rejected under 35 USC 103(a) as being unpatentable over Mintzer in view of Klassen. The Examiner has suggested that balancing seed values out to zero by making each set of seed values 120 degrees out of phase would be obvious to one of ordinary skill when faced with the three sets of seed values taught by Mintzer.

The technique of using multiple random variables to generate multiple sets of seed values that are all 120 degrees out of phase is not described in Mintzer or Klassen as explained above. Mintzer does even suggest generating seed values from multiple random numbers as specified in claim 24. Therefore, it would not be obvious for someone with average skill in the art to make these seed values 120 degrees out of phase, since there is no suggestion in any of the cited prior art to even generate three sets of seed values from two random numbers.

The values referred to in Mintzer are not error diffusion seed values as specified in the present claims. Claim 24 explicitly specifies using the seed values as initial error values for use in starting up an error diffusion process. Claim 24 also does not specify balancing the seed values out to zero. The choice of 120 degree separation in the seed vector generation trig calculations promotes the mutual negative correlation of the three treated channels (e.g., C, M, and K). This increases the chance of dot-off-dot output among the three treated channels and is not the same as balancing the seed values out to zero as suggested by the Examiner.

It is not obvious to generate randomly generated seed values and then adjust the seed values to be out of phase. The very nature of random values is that they are random and not associated with any particular pixel data. Thus, generating random error diffusion seed values and adjusting the values to be 120 degrees out of phase with other random error

diffusion seed values associated with other color planes provides an unexpected result of reducing certain error diffusion artifacts that would still exist in the digital half-toning systems described in the prior art.

The fact that Mintzer describes three sets of seed values and Klassen only contemplates modifying the non-black colors to compensate for the black color shows that it is not obvious to generate three sets of seed values that are each 120 degrees out of phase. If it were obvious, or necessary, it would have been suggested in Mintzer or Klassen. In fact, in some printing applications, such as described in Klassen, it may not be desirable to have each color plane to be 120 degrees out of phase, when a more dominant color, such as black, could possibly require different weighting than other colors.

Accordingly, claim 24 is allowable under 35 USC 103(a) over Mintzer in view of Klassen.

No new matter has been added by this amendment. Allowance of all claims is requested. The Examiner is encouraged to telephone the undersigned at (503) 222-3613 if it appears that an interview would be helpful in advancing the case.

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